CLAIMS

Having thus described the invention, what is CLAIMED is:

1. A method for determining the temperature T at at least one location on the surface of a sample, comprising the steps:

(a) measuring, at an oblique take-off angle and at at least one wavelength ν, radiance at at least two linearly independent polarizations p1 and p2;

(b) computing a polarized radiance ratio $R_{p1}(\nu)/R_{p2}(\nu)$ of said measured radiances $R_{p1}(\nu)$, $R_{p2}(\nu)$ to determine the associated polarized emissivity ratio $\epsilon_{p1}(\nu)/\epsilon_{p2}(\nu)$, in accordance with the relationship $R_{p1}(\nu)/R_{p2}(\nu) = \epsilon_{p1}(\nu)/\epsilon_{p2}(\nu)$;

(c) applying at least one additional constraint to compute the value of at least one of the emissivities, $\epsilon_{p1}(\nu)$, $\epsilon_{p2}(\nu)$, constituting said polarized emissivity ratio; and

(d) determining the temperature T at said one location by solving the equation:

$$R_{p1}(\nu,T) = \epsilon_{p1}(\nu T) \times P(\nu,T),$$

wherein $P(\nu,T)$ is the Planck function.

2. The method of Claim 1 wherein one of said polarizations p1 and p2 is determined in the parallel direction, and the other of said polarizations p1 and p2 is determined in the perpendicular direction, both with reference to the take-off plane.

3. The method of Claim 1 wherein said surface is the surface of a film comprising said sample, said method including the further step of utilizing one of said polarized radiance ratio and said polarized emissivity ratio to determine at least one additional parameter of said film, said parameter being selected from the group consisting of thickness, composition, roughness, crystallinity, interface quality, and strain.

4. The method of Claim 1 including the further steps of irradiating said surface with radiation including said wavelength ν, and measuring reflectance ρ from said surface at said wavelength ν and said polarizations p1 and p2 to thereby determine the reflectance-derived ratio $1-\epsilon_{p1}(\nu)/1-\epsilon_{p2}(\nu)$, and applying said reflectance-derived ratio as said at least one additional constraint in said step (c) for computing said at least one emissivity value.

5. The method of Claim 1 wherein said additional constraint of said step (c) is determined from model-based analysis using at least one layered optical stack model incorporation a Fresnel model for interfaces.

6. The method of Claim 5 wherein said model-based analysis utilizes a fitting routine in which at least one parameter selected from the class consisting of film thickness, composition, optical properties, and fractional area within a measurement spot is varied to achieve values consistent with said determined polarized emissivity ratio.

7. The method of Claim 1 including the additional step of providing a look-up table in which values of emissivity are correlated to values of polarized emissivity ratios, and wherein the emissivity value in said look-up table, corresponding to said determined emissivity ratio, constitutes said additional constraint applied in said step (c).

8. The method of Claim 1 wherein said steps (a) through (d) are repeated at each of a multiplicity of locations on said sample surface to develop a temperature distribution map of said surface.

9. A method for determining the emissivity ϵ at at least one location on the surface of a sample, comprising the steps:

(a) measuring, at an oblique take-off angle and at at least one wavelength ν, radiance at at least two linearly independent polarizations p1 and p2;

(b) computing a polarized radiance ratio $R_{p1}(\nu)/R_{p2}(\nu)$ of said measured radiances $R_{p1}(\nu)$, $R_{p2}(\nu)$ to determine the associated polarized emissivity ratio $\epsilon_{p1}(\nu)/\epsilon_{p2}(\nu)$, in accordance with the relationship $R_{p1}(\nu)/R_{p2}(\nu) = \epsilon_{p1}(\nu)/\epsilon_{p2}(\nu)$; and

(c) applying at least one additional constraint to compute the value of at least one of the emissivities, $\epsilon_{p1}(\nu)$, $\epsilon_{p2}(\nu)$, constituting said polarized emissivity ratio.

10. The method of Claim 9 wherein one of said polarizations p1 and p2 is determined in the parallel direction, and the other of said polarizations p1 and p2 is determined in the perpendicular direction, both directions being taken with reference to the take-off plane.

11. The method of Claim 9 including the further steps of irradiating said surface with radiation including said wavelength ν, and measuring reflectance ρ from said surface at said wavelength ν and said polarizations p1 and p2 to thereby determine the reflectance-derived ratio $1\text{-}\epsilon_{p1}(\nu)/1\text{-}\epsilon_{p2}(\nu)$, and applying said reflectance-derived ratio as said at least one additional constraint in said step (c) for computing said at least one emissivity value.

12. The method of Claim 9 wherein said additional constraint of said step (c) is determined from model-based analysis using at least one layered optical stack model incorporation a Fresnel model for interfaces.

13. Apparatus for determining at least one emissivity value ϵ from a surface of a simple, comprising a radiance sensor including a radiation detector, polarization selective means, wavelength selective means, and electronic data processing means, said sensor being configured for carrying out the following steps:

(a) measuring, at an oblique take-off angle and at at least one wavelength ν, radiance at at least two linearly independent polarizations p1 and p2;

(b) computing a polarized radiance ratio $R_{p1}(\nu)/R_{p2}(\nu)$ of said measured radiances $R_{p1}(\nu)$, $R_{p2}(\nu)$ to determine the associated polarized emissivity ratio $\epsilon_{p1}(\nu)/\epsilon_{p2}(\nu)$, in accordance with the relationship $R_{p1}(\nu)/R_{p2}(\nu) = \epsilon_{p1}(\nu)/\epsilon_{p2}(\nu)$; and

(c) applying at least one additional constraint to compute the value of at least one of the emissivities, $\epsilon_{p1}(\nu)$, $\epsilon_{p2}(\nu)$, constituting said polarized emissivity ratio.

14. The apparatus of Claim 13 wherein said sensor is further configured to carry out the additional step of determining the temperature T at said one location by solving the equation:

$$R_{p1}(\nu,T) = \epsilon_{p1}(\nu T) \text{ x } P(\nu,T),$$

wherein $P(\nu,T)$ is the Planck function.

15. The apparatus of Claim 13 wherein said polarization selective means is a polarizer selected from the group consisting of wire grid, glan, and Brewster polarizers.

16. The apparatus of Claim 13 wherein said wavelength selective means is a device selected from the group consisting of interference filter sets, tunable filters, gratings, prisms, Michelson interferometers, and FT-IR spectrometers.

17. The apparatus of Claim 16 wherein said sensor comprises an FT-IR spectrometer.

18. The apparatus of Claim 13 additionally including a source of illuminating radiation disposed for projecting a beam of radiation toward a surface of a sample being subjected to emissivity determination therein.

19. The apparatus of Claim 18 wherein said source of the illuminating radiation and said sensor are so disposed that the beam of radiation from said source is reflected by the sample to said sensor.

20. The apparatus of Claim 18 additionally including means for modulating the beam of radiation from said source.

21. The apparatus of Claim 13 wherein said sensor incorporates a look-up table by which emissivity values are correlated to values of polarized emissivity ratios.